

# **FRED Reports**

**CROOKED CREEK CHINOOK SALMON**

**1979-1981**

**by**

**David C. Waite**

**Edited by**

**William J. Hauser**

**Number 14**



**Alaska Department of Fish & Game**  
**Division of Fisheries Rehabilitation,**  
**Enhancement and Development**

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Alaska Department of Fish and Game  
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Crooked Creek Chinook Salmon  
1979-1981

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edited by  
William J. Hauser

ABSTRACT

Hatchery chinook salmon, Oncorhynchus tshawytscha (Walbaum), have been returning to Crooked Creek, Cook Inlet, Alaska since 1976. Wild chinook salmon from Crooked Creek have been used as a brood source since 1974 and smolts have been released since 1975. Hatchery smolts are released as age 0's averaging 19.1 g/fish. These smolts are released during the last week of May or the first week of June. Crooked Creek Hatchery and wild chinook salmon return after 1 to 4 years in the ocean. Hatchery returns are complete for three brood years (1974 through 1976). The estimated average survival rate from smolt to adult is 1.4%.

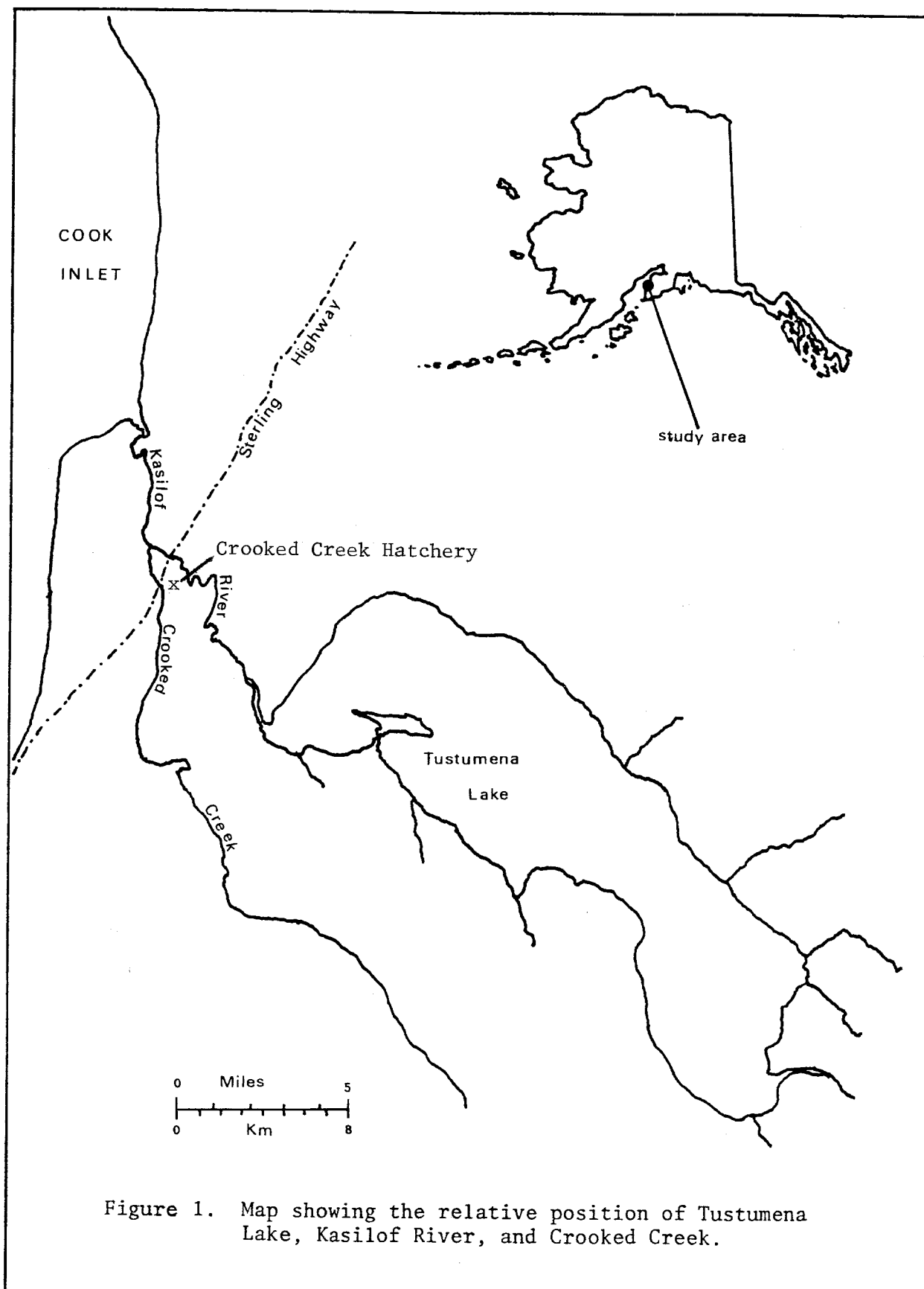
A total escapement (all ocean age classes) of 3,830 chinook salmon returned in 1979, 2,536 in 1980, and 3,010 in 1981. Hatchery returns accounted for 1,009 (26%) in 1979, 723 (27%) in 1980, and 1,033 (34%) in 1981. There were few significant differences in age, weight, length, and run timing between hatchery and wild returning chinook adults in Crooked Creek.

Returning Crooked Creek chinook salmon are intercepted in a sport fishery below the mouth of Crooked Creek on the Kasilof River. The fishery starts in mid-May and ends on 30 June. Creel surveys were conducted from 1978 through 1981. An estimated 283 fish in 1979, 320 in 1980, and 1,283 in 1981 were caught. In 1979 an estimated 62 (22%) of these sport caught chinooks were of hatchery origin, 78 (25%) in 1980, and 454 (35%) in 1981.

INTRODUCTION

Crooked Creek is located on the Kenai Peninsula, Cook Inlet, Alaska (Figure 1). It originates as a small spring in the Caribou Hills. The creek is approximately 80.5 km (50 mi) long and it meanders through low grass and bog areas, so the water is fairly turbid with suspended solids such as peat moss. The confluence of Crooked Creek and the Kasilof River is approximately 6.4 km (4 mi) from Cook Inlet and 3.2 km (2 mi) from tidal influence.

Chinook salmon, Oncorhynchus tshawytscha (Walbaum), is the dominant salmon-species in Crooked Creek and has shown a steady increase in escapement during the past 4 years. Although there are limited data prior to 1974, large chinook salmon runs to Crooked Creek have been reported (Dederick, pers. comm. 1975). The chinook salmon adult escapement has been monitored since 1974 by the Division of Fisheries Reha-



bilitation, Enhancement, and Development (FRED) of the Alaska Department of Fish and Game (ADF&G).

Studies during the 1979 through 1981 field seasons were part of an ongoing project which originated in 1976. Although this report emphasizes results from 1979-1981, some information from previous years is also presented. Waite (1979) previously reported on early life history aspects of chinook salmon in Crooked Creek.

These early life history studies included minnow trapping for pre-smolts throughout the study area to determine age, growth, habitat utilization and distribution of smolts in 1976. The primary purpose of this project was to enhance the Crooked Creek chinook salmon run with planted hatchery smolts. This was accomplished by taking eggs from Crooked Creek chinook salmon at the Crooked Creek Hatchery. Crooked Creek has provided a source of chinook salmon eggs as a brood-stock for various programs of the FRED Division since 1974. A history of egg takes including escapement, numbers of adults held, eggs procured, and fecundity is included in Appendix Table A.

Objectives of this project from 1979 to 1981 include the determination of the following:

- 1) smolt to adult survival of hatchery-released chinook salmon,
- 2) the contribution of wild and hatchery chinook salmon to the sport fishery,
- 3) the contribution of returning hatchery chinook salmon to the total Crooked Creek escapement, and
- 4) the age, weight, and length, of hatchery-produced and wild chinook salmon in Crooked Creek.

## METHODS AND MATERIALS

### Smolt Release

Crooked Creek chinook salmon smolts from the 1974 through 1980 brood years were released in Crooked Creek at the hatchery in the spring of each year from 1975 through 1981. These smolts originated from chinook salmon eggs collected from Crooked Creek stocks and transported to the Fort Richardson Hatchery, near Anchorage, for incubation. The Fort Richardson Hatchery has a warm water source so that smolts can be produced in less than 1 year. Crooked Creek chinook smolts were transported back to Crooked Creek by hatchery transport trucks. A portion of the released chinook smolts each year were marked by removing the adipose fin and inserting coded wire tags (CWT's).

### Adults

Data were obtained from adult chinook salmon caught from Crooked Creek both at the weir at Crooked Creek Hatchery and in the sport fishery at the confluence of Crooked Creek and the Kasilof River (Figure 1).



#### Capture and Enumeration:

A weir with temporary holding pens was used to help take eggs and count returning adults to the Crooked Creek Hatchery during 1979 and 1980. A new holding facility for adult salmon was constructed in the winter of 1980-81 and was first used in 1981 (Figure 2). When the old weir system was used, the fish were netted and passed over the weir as they were counted and examined. In the new holding facility an aluminum weir diverted the chinook salmon adults from the main stream into the holding pond chute entrance. With this new design, water flowing from the chute entrance would attract the adult chinook salmon into the chute. A one way entrance to the trap prevents adults from returning to the creek. Crowders at each end of the chute move to concentrate the chinook salmon in front of one of the holding ponds. After crowding, the chinook salmon are easily netted so samples can be taken, tallied, and placed in a holding pond or released upstream from the weir.

Chinook salmon arrived at the weir each day, but they were not handled each day because of low numbers of fish, insufficient manpower, a weekend, or a holiday.

Because of design limitations of the weir and hatchery intake, and the comparatively small size of hatchery and wild chinook salmon precocious males (jacks), some were able to bypass the weir. Consequently, a quantitative count of this age class was not obtained.

#### Data Collection:

Fish ages are expressed as age .1, .2, .3 or .4; referring to the number of years that the chinook salmon spent in salt water. (Based on the European Formula: Number of freshwater annuli - decimal - number of saltwater annuli. Total age is the sum of these two numbers plus 1.) This includes both hatchery and wild chinook salmon. During 1979 through 1981, 20% of the total chinook salmon escapement was examined. Scales were collected to determine individual ages. Weights (0.1 kg) and mid-eye to tail fork lengths were measured in centimeters. To obtain a random sample, every fifth fish tallied was sampled. Sex was determined for each chinook salmon entering the structure. Ocean age .1 and .2 chinook salmon can be readily separated by their length differences. However, scales were taken from these fish if they were included in the sample group. Some overlap of sizes of chinook salmon occur between age .1 and .2; age .2 and .3; and age .3 and .4. The lengths of age .3 and .4 have a greater overlap in size. Final verification of all age classes was done through scale analysis. Since approximately 20% of all hatchery smolts released into Crooked Creek had been marked by removing their adipose fin and inserting a distinctive CWT for each year, all chinook salmon at the weir were also examined for the absence of adipose fins. All of the fish without adipose fins were killed in 1979, and one-fifth of the hatchery marked fish recovered were killed in 1980 and 1981. Coded wire tags were extracted from the chinook salmon heads and the code was read and verified.

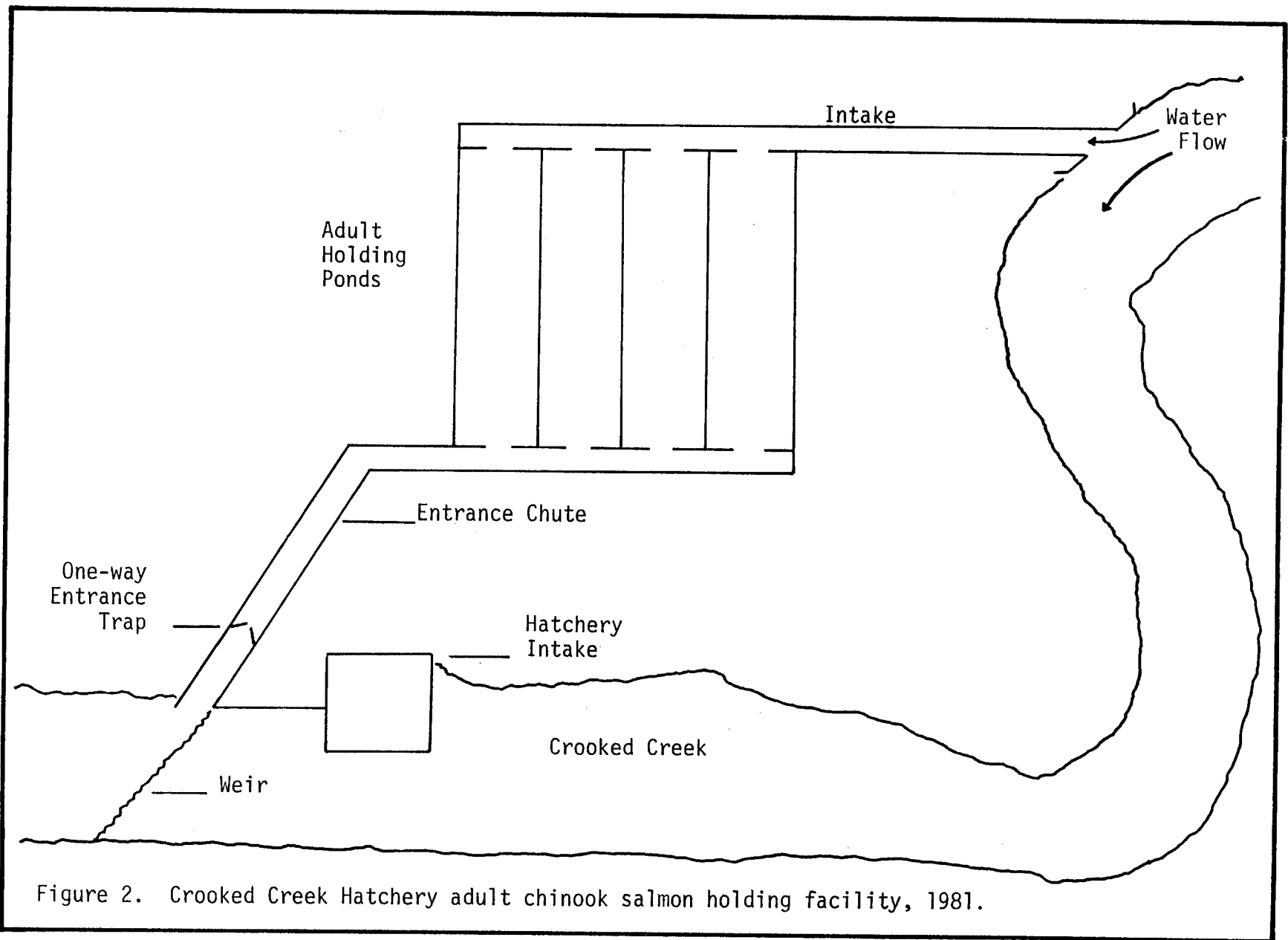


Figure 2. Crooked Creek Hatchery adult chinook salmon holding facility, 1981.

### Creel Survey:

The sport fishery for Crooked Creek adult chinook salmon opened for the first time by regulation in 1978. Typically the fishing season begins mid-May and closes 30 June. During 1978 and 1979 fishing was restricted by regulation to approximately two-thirds of the available area (Figure 3). During part of 1980 (starting 12 June 1980) and all of 1981, the regulations were changed to allow fishing up to the mouth of Crooked Creek.

Creel census surveys for the chinook salmon sport fishery started in 1978. The first survey was conducted by the Sport Fish Division (SFD of the ADF&G). Personnel from SFD did not look for adipose fin clipped fish, however, personnel from the FRED Division did look for marked fish. All the creel surveys in 1979 through 1981 were conducted by the FRED Division personnel and fish were examined for marks. Creel surveys were designed to estimate the catch of adult chinook salmon and the effort expended in angler-days. The creel census sampling scheme was the same as that used by SFD in the Soldotna area (ADF&G 1978). A sampling-day was defined as 20 h long, commencing at 0400 hours and terminating at 2400 h. The fishing season was stratified into weekend/holiday and weekdays (except 1979). In 1980 and 1981 the sample scheme was modified so that the 1-hour counts occurred three times a day starting approximately at 0900, 1300, and 2000 h.

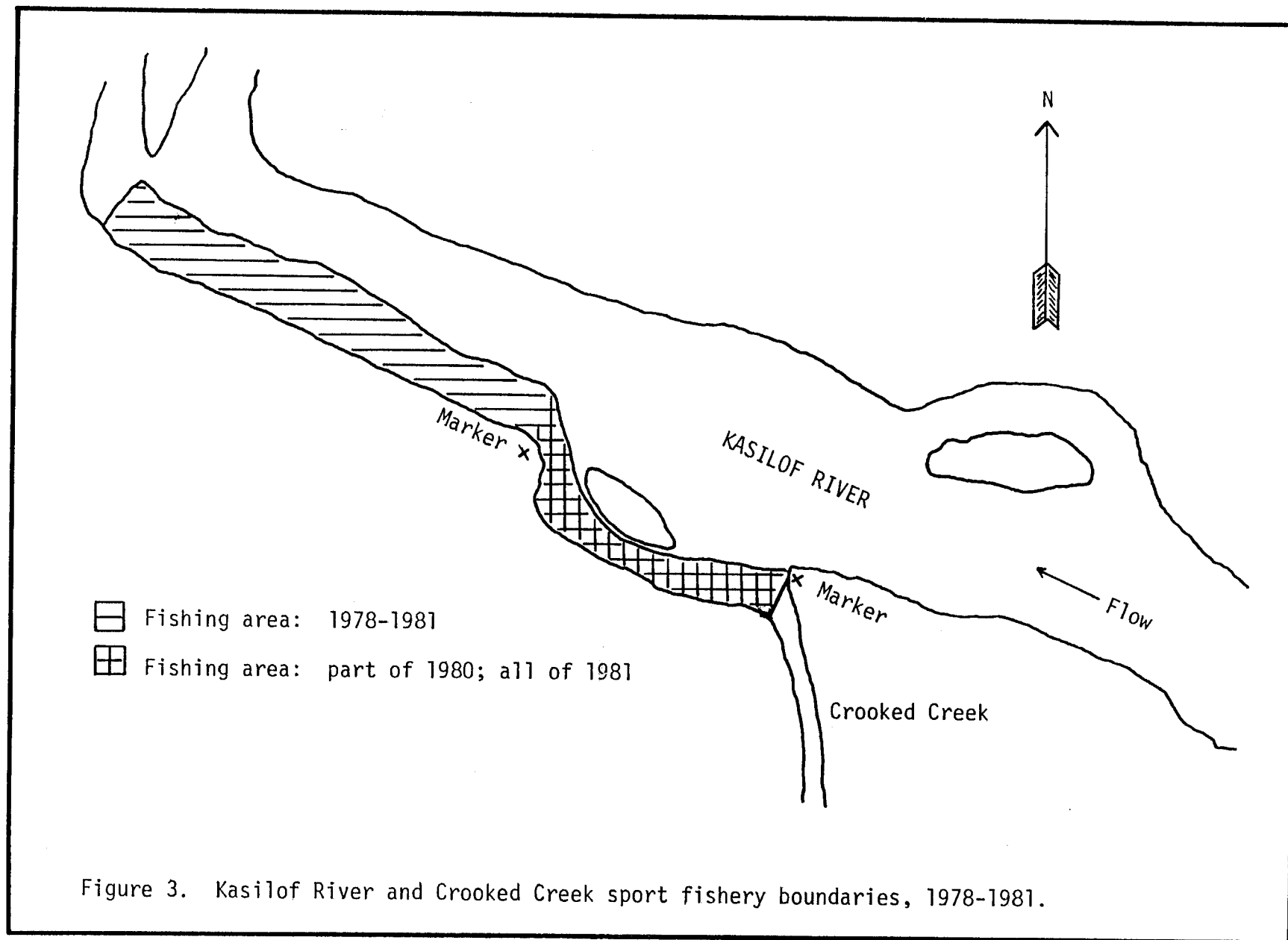
The methods used to calculate effort and harvest were identical to those used by the SFD (Hammarstrom 1976). Effort in total angler-hours (E) for an individual category (weekend, holiday, weekday, and total) was estimated for the whole season as follows:

$$E = \bar{c}N$$

$\bar{c}$  = mean number of anglers per count for season (weekend/holiday, weekday, or total) =

$$\frac{\text{Total number of anglers counted in 1-h periods for season}}{\text{Total number of 1-h counts in season}}$$

N = Number of days (weekend/holiday, weekdays or total) x 20 h/day.



The harvest (H) was calculated as follows:

$$H = E \bar{r}$$

E = effort (total angler-hours)

$\bar{r}$  = mean catch per hour (harvest rate) =  $\frac{\text{total fish recorded}}{\text{total hours recorded}}$

Effort in angler-days was determined by dividing total angler-hours (E) by the average angler-day.

$$\text{Average angler-day} = \frac{\text{Total hours reported by anglers (season)}}{\text{Total anglers}}$$

A public information campaign for the sport fishery used posters which explained the marked chinook salmon and coded wire tagging program. The public was encouraged to return heads of fish missing their adipose fin to the personnel at Fish and Game office or Crooked Creek Hatchery. Recovered CWT's from these heads were not used to determine hatchery contribution, but were used only for identification and age composition.

#### Hatchery Contribution:

The method used to determine the number of hatchery fish among the chinook salmon returning to Crooked Creek was based on the numbers of marked fish observed without correction for lost CWT's or naturally missing adipose fins. Though all the adult chinook salmon enumerated at the weir were examined for marks, only a portion of the hatchery smolts at release were marked, so the total hatchery contribution was estimated based on the marked/unmarked fish ratios. The CWT was used to determine what portion of the run was contributed by each release year. The survival rate from smolt to adult for Crooked Creek hatchery chinook salmon and the portion of the escapement and sport catch and the variances for hatchery-produced fish were calculated using formulas developed by Reed (1981). The age 0.1 contribution in 1981 was determined by scale analyses since the smolts released in 1980 were not marked with CWT's or removal of adipose fins.

Total run was defined as escapement at weir plus those caught in the sport fishery. Percentage of tag loss was determined from numbers of adipose fin clipped chinook salmon that did not have CWT's present. To test if tags were demagnetized, those heads that were negative were passed near a large magnet for remagnetification.

Comparisons were made between hatchery and wild fish to determine if statistically significant differences existed in age structure, weight, lengths, and run timing between hatchery-released and wild chinook salmon (Snedecor and Cochran 1967).

## RESULTS

### Smolt Release

Crooked Creek chinook salmon smolts were released in Crooked Creek near the Crooked Creek Hatchery from 1975 through 1981. Numbers of chinook salmon smolts released averaged 146,420 (ranging from 3,679 to 379,478) per year (Table 1). An average of 21% (ranging from 0-100%) were marked and a distinctive CWT inserted. The average size of the smolts at the time of release was 19.1 g (ranging from 13.6 g to 28.3 g). None of the 51,998 chinook smolts released in 1980 were marked because the lot which included the marked fish was disposed of after enteric (Red Mouth) disease was detected among these fish.

### Adults

#### Capture and Enumeration:

In 1979 the adult chinook salmon run started 30 May and ended 24 August (Appendix Table B). A total of 3,544 chinook salmon (excluding age .1) was enumerated with the peak escapement occurring between 2 July 1979 and 12 July 1979. The 1980 adult chinook salmon run started 6 June and ended 20 August. A total of 2,282 chinook salmon (excluding age .1) was enumerated with the peak escapement occurring between 6 July and 12 July 1980.

Although the adult chinook salmon run in 1981 started 9 June and ended 14 August, the entrance chute was not ready to hold fish until 16 June; consequently, none was counted or passed over the weir until then. A total of 2,904 chinook salmon (excluding age .1) was enumerated with the peak escapement occurring between 5 July and 10 July 1981. The highest weekly average escapement occurred between 4 July and 10 July during each of the three years (Figure 4).

A total of 823 fish (23% of the run) was sampled in 1979; 523 fish (23%) in 1980; and 598 fish (21%) in 1981. The male to female ratio for the adult chinook salmon was 1:1 for all three years. Most adults returned after three years in the ocean (Figure 5). The average length of chinook salmon in each age class of 1979 through 1981 was similar (Figure 6 and Appendix Table C). Escapements for the Crooked Creek chinook salmon (including age .1, .2, and marked chinook salmon) were recorded at the weir and holding facility for each day that fish were handled (Appendix Tables D through F).

#### Creel Survey:

In 1978 the catch rate was 0.032 fish/hour (31 hours to catch one adult) on weekends and holidays and 0.043 fish/hour (23 hours to catch one adult) on weekdays. Average fishing pressure (anglers per hour) was greater on weekends than on weekdays; 6.6 and 5.7 anglers per hour, respectively. In 1980 the catch rate was 0.014 fish/hour or (73 hours to catch one adult) on weekends and holidays and 0.022 fish/hour (45 hours to catch one adult) on weekdays. Average fishing pressure

Table 1. Smolt releases of Crooked Creek chinook salmon, 1975-1981.

Brood year	Date of release	Mean grams/fish	Number released	Number tagged	Percent tagged	Tag code
1974	8/5/75	28.3	3,679	3,679	100	4-2-2
1975	5/18-21/76	19.6	82,000	20,600	25	4-4-5
1976	6/6-14/77	24.9	131,287	50,023	38	4-17-1
1977	6/7-9/78	16.5	172,512	38,046	22	4-18-2
1978	5/30- 6/22/79	15.9	379,478	57,040	15	4-18-59 4-18-60
1979	4/14/80	13.6	51,998	0	0	...
1980	5-28-29/81	<u>14.9</u>	<u>203,988</u>	<u>50,586</u>	<u>25</u>	4-20-34
Mean		19.1	146,420	31,425	21	

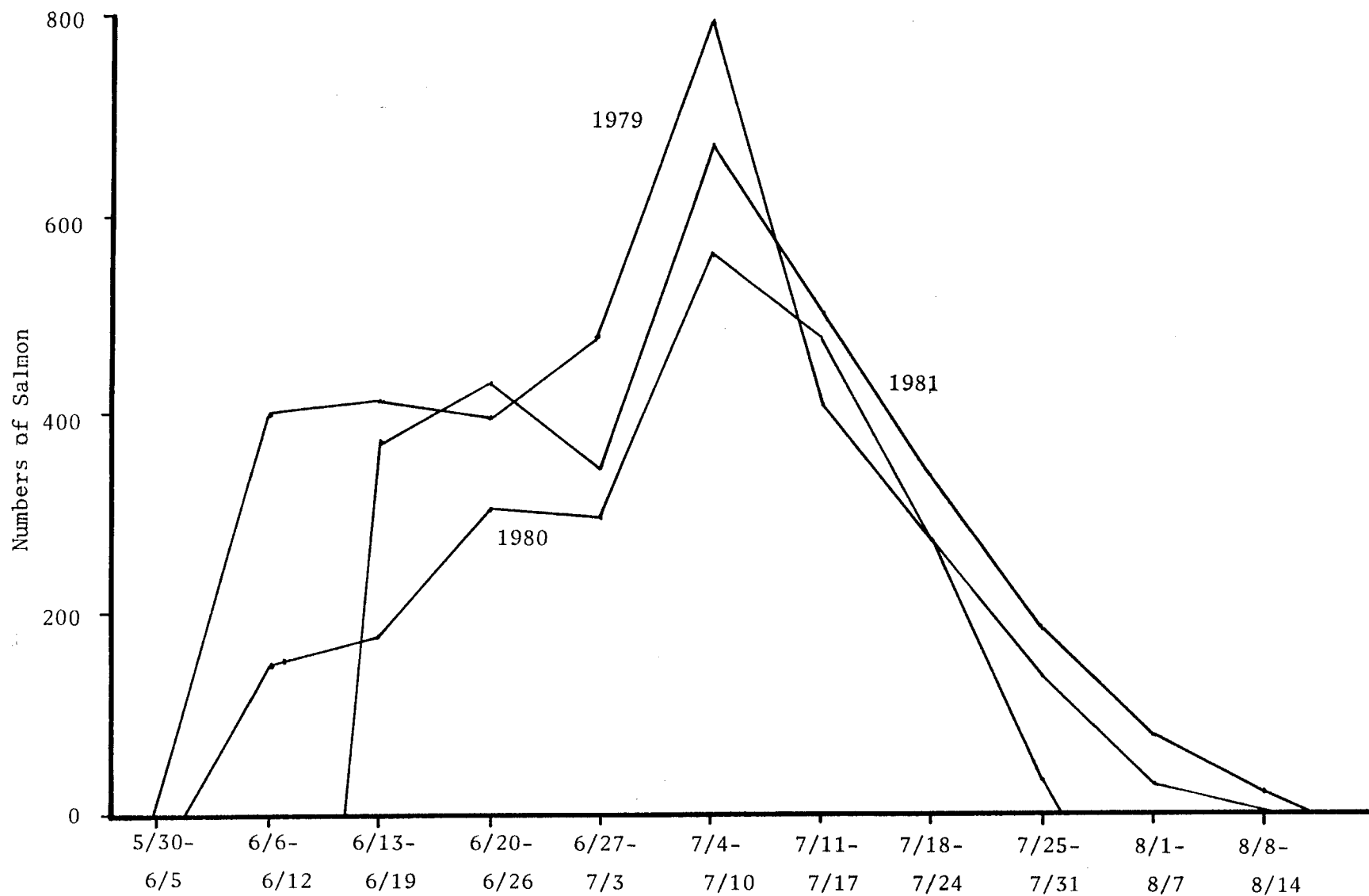


Figure 4. Weekly total of Crooked Creek chinook salmon run timing, 1979-1981.



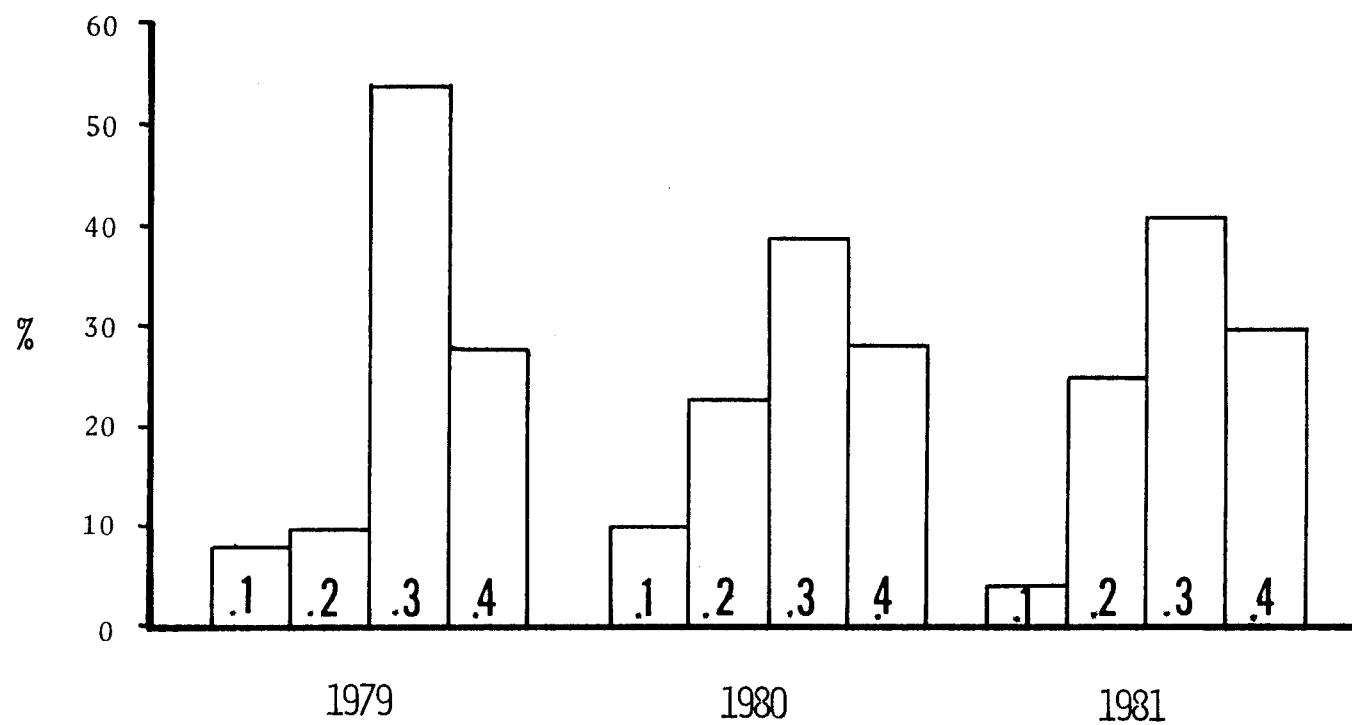


Figure 5. Percentage of Crooked Creek chinook salmon in each ocean age group, 1979-1981.

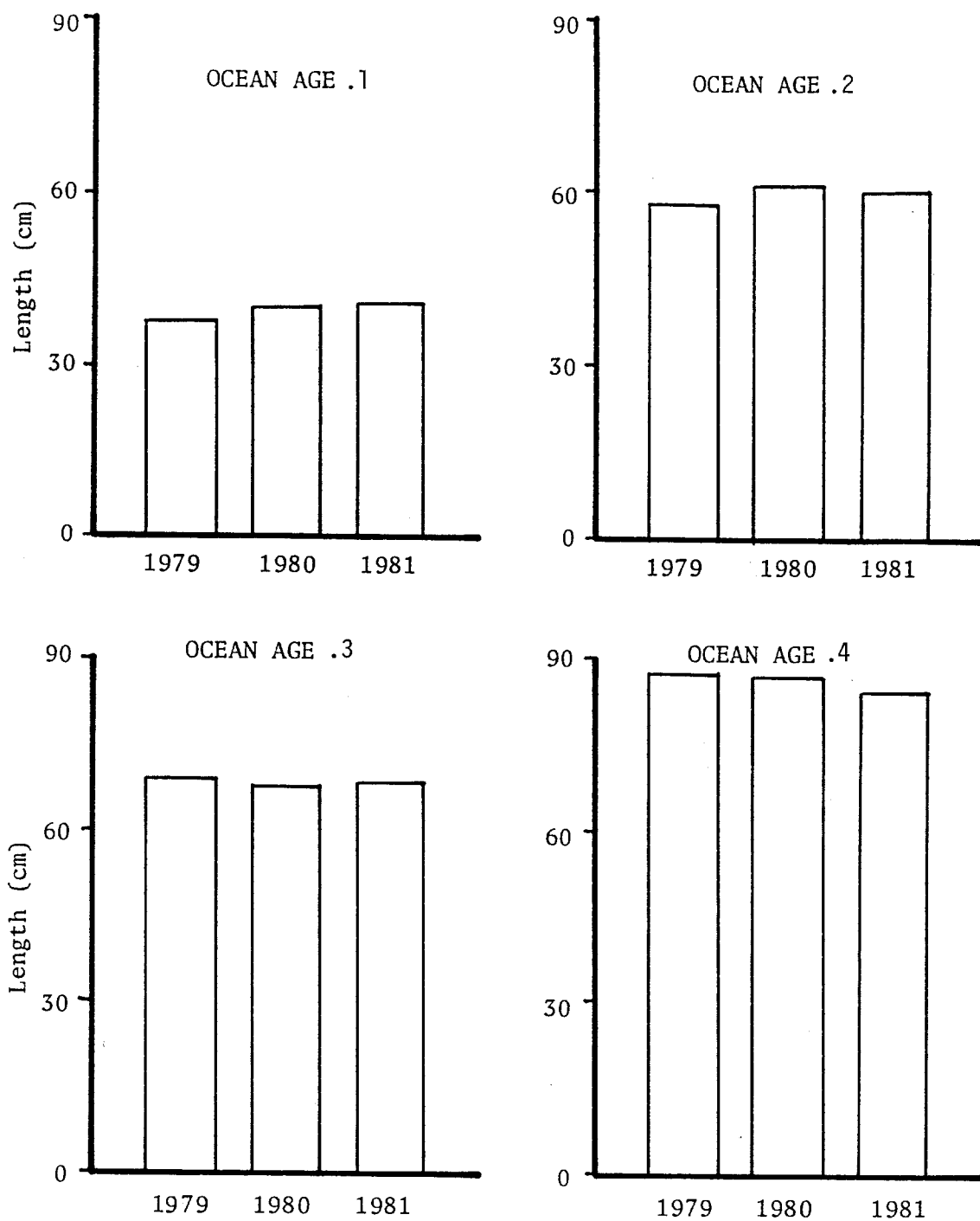


Figure 6. Average length for each ocean-age of the Crooked Creek chinook salmon adults, 1979-1981.

(anglers per hour) was greater on weekends than on weekdays; 21.3 and 15.5 anglers per hour, respectively. In 1981 the catch rate was 0.057 fish/hour (18 hours to catch one adult) on weekends and holidays and 0.064 fish/hour (16 hours to catch one adult) on weekdays. Average fishing pressure was greater on weekends than on weekdays; 33.6 and 23.1 anglers per hour, respectively.

The numbers of chinook salmon caught by sport fishermen was 251 in 1978; 283 in 1979; 320 in 1980; and 1,283 in 1981 (Table 2). The harvest rate (excluding age .1) of the Crooked Creek chinook salmon run by sport fishermen was 5% in 1978, 7% in 1979, 12% in 1980, and 30% in 1981.

#### Hatchery Contribution:

Hatchery fish comprised 4% (1978), 24% (1979), 28% (1980), and 35% (1981) of chinook caught by sportsmen (Table 2). Returns from the Crooked Creek Hatchery chinook salmon smolt releases for three separate brood years are complete (1974 through 1976). Smolts from each brood year were released the following spring and returns occurred from 1 to 4 years after release (ages .1 through .4) (Table 3, Table 4). The estimated hatchery smolt to adult survival, calculated from the marked fish recovered at weir and in the sport fishery for the brood years 1974 to 1976, was 1.9%, 1.4%, and 0.9%, respectively (Table 5). The estimated hatchery contribution (number of fish) for the 1974 to 1976 brood year was 70, 1,170, and 1,237, respectively (Table 6).

From 1979 to 1981, all of the marked chinook salmon that were killed were checked for CWT's. A total of 256 marked chinook salmon was killed in 1979, 48 in 1980, and 76 in 1981. A total of 211 tags was recovered in 1979, 40 in 1980, and 63 in 1981. Percentage of tag loss in 1979 through 1981 was 18%, 17%, and 17%, respectively.

During 1979, 1980, and 1981; hatchery-reared chinook salmon comprised 26.3%, 28.5%, and 34.3%, respectively, of the escapement (Table 7). During 1980 and 1981, hatchery-reared chinook salmon contributed proportionately more adults than the wild chinook salmon to the age .1 and .2 escapement and fewer to the ages .3 and .4 escapement (Table 7).

There were few significant differences between lengths and weights of hatchery-released and wild chinook salmon in Crooked Creek for all salt water ages (Figure 7, Table 8). During both 1980 and 1981, wild age .4 adults were 4 cm longer ( $P < .001$ ) than hatchery age .4 adults; age .3 wild adults were 0.7 kg heavier ( $P < .001$ ) than age .3 hatchery adults; and age .4 wild adults were 1.3 and 1.8 kg heavier than age .4 hatchery adults.

Though there were slight differences in the run timing between marked and unmarked chinook salmon in Crooked Creek from 1979 through 1981, there were no obvious trends (Figure 8).

Since the scales of hatchery-produced chinook salmon in Crooked Creek are characterized by the absence of a freshwater winter check and exhibit a fast growth rate in the freshwater zone, scale analysis of returning adults may provide a means of distinguishing hatchery-produced

Table 2. Kasilof River chinook salmon sport fishery summary (age .1 not included), 1978-1981.

Year	Harvest	Hatchery Number	Contribution Percent	Effort (man-days)	Catch/angler hour
1978	251	10	4.0	1,750	0.038
1979	283	68	24.0	2,013	0.040
1980	320	88	28.0	4,830	0.019
1981	1,283	454	35.4	8,751	0.061
Mean	534	151	29.0	4,336	0.040

Table 3. Hatchery smolt releases and recoveries of chinook salmon in the escapement in Crooked Creek, 1974-1981.

Brood year	Release date	Number released		Number examined and number of marked fish recovered by brood year											
				1976		1977		1978		1979		1980		1981	
		Total	Marked	Number returned and examined	Number marked	Number returned and examined	Number marked	Number returned and examined	Number marked	Number returned and examined	Number marked	Number returned and examined	Number marked	Number returned and examined	Number marked
1974	8/5/75	3,679	3,679	ND	ND	670	2	2,084	26	1,154	12				
1975	5/18-21/76	82,000	20,600			390	54	1,170	39	2,050	163	722	23		
1976	6/6-14/77	131,287	50,023					681	231	340	42	973	83	867	47
1977	6/7-9/78	172,512	38,046							286	53	587	46	1,248	67
1978	5/30-6/22/79	379,478	57,040									254	31	789	91
1979	4/14/80	51,998	0											106	0
1980	5/28-5/29/81	203,988	50,586												
Total 1974-1979				1,682 <sup>1</sup>	0	3,459 <sup>1</sup>	56	5,396 <sup>1</sup>	296	3,830	270	2,536	183	3,010	205

<sup>1</sup>Includes brood years prior to 1974.

Table 4. Hatchery smolt releases and recoveries of chinook salmon in the sport fisheries in Crooked Creek, 1974-1981.

Brood year	Release date	Number released		Number examined and number of marked fish recovered by brood year																	
				1976			1977			1978			1979			1980			1981		
				Number			Number			Number			Number			Number			Number		
		Total	Marked	Caught	Examined	Marked	Caught	Examined	Marked	Caught	Examined	Marked	Caught	Examined	Marked	Caught	Examined	Marked	Caught	Examined	Marked
1974	8/5/74	3,679	3,679	ND	ND	ND	ND	ND	ND	118	13	2	78	10	0						
1975	5/18-21/76	82,000	20,600				ND	ND	ND	50	3	0	112	18	1	103	21	1			
1976	6/6-14/77	131,287	50,023							211	15	1	93	21	3	134	26	2	403	61	4
1977	6/7-9/78	172,512	38,046										176	32	2	83	16	1	581	89	7
1978	5/30-6/22/79	379,478	57,040													237	47	5	299	45	4
1979	4/14/80	51,998	0																ND	ND	0
1980	5/28-5/29/81	203,988	50,586																		
Total 1974-1979										462 <sup>1</sup>	31	3	459	81	6	557	110	9	1,283	195	15

<sup>1</sup>Includes an estimated total of 83 age IV's caught in sport fishery.

Table 5. Survival rates ( $\pm 95\%$  confidence interval) of hatchery-produced chinook salmon in the sport fishery and escapement in Crooked Creek, 1974-1981.

Brood year	Return year												Total	
	1976		1977		1978		1979		1980		1981			
	Survival rate		Survival rate		Survival rate		Survival rate		Survival rate		Survival rate			
	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement		
1974	ND	ND	ND	0.00054 ±0.00000	0.00810 ±0.01050	0.00707 ±0.00000	0.00000 ±0.00000	0.00327 ±0.00000						0.01897
1975			ND	0.00262 ±0.00060	0.00000 ±0.00000	0.00189 ±0.00051	0.00028 ±0.00052	0.00791 ±0.00105	0.00049 ±0.00034	0.00112 ±0.00039				0.01431
1976					0.00030 ±0.00057	0.00462 ±0.00047	0.00034 ±0.00037	0.00084 ±0.00028	0.00020 ±0.00027	0.00166 ±0.00014	0.00053 ±0.00050	0.00094 ±0.00021		0.00943
1977							0.00030 ±0.00040	0.00139 ±0.00033	0.00013 ±0.00026	0.00121 ±0.00031	0.00121 ±0.00087	0.00176 ±0.00037		0.00600
1978									0.00044 ±0.00038	0.00054 ±0.00018	0.00046 ±0.00044	0.00160 ±0.00030		0.00304
1979												ND ND	ND ND	ND

Table 6. Numbers (95% confidence interval) of hatchery-produced chinook salmon in the sport fishery and escapement in Crooked Creek, 1974-1981.

Brood year	Return year												Total
	1976		1977		1978		1979		1980		1981		
	Contribution		Contribution		Contribution		Contribution		Contribution		Contribution		
	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	Sport fishery	Escapement	
1974	ND	ND	ND	2 0	30 ±39	26 0	0 0	12 0					70
1975			ND	214 ±49	0 0	154 ±42	23 ±43	648 ±86	40 ±28	91 ±32			1,170
1976					39 ±75	606 ±62	45 ±49	110 ±37	26 ±35	218 ±18	70 ±66	123 ±28	1,237
1977							52 ±69	239 ±57	22 ±45	209 ±54	209 ±150	303 ±64	1,034
1978									167 ±144	205 ±68	175 ±167	607 ±114	1,154
1979	—	—	—	—	—	—	—	—	—	—	ND	ND	ND
Total	ND	ND	ND	216	69	786	120	1,009	255	723	454	1,033	4,665



Table 7. Hatchery contribution of adult Crooked Creek chinook salmon to the escapement, 1979-1981.

Return year	Ocean age	Escapement	Number scales analyzed	Percent within age group	Hatchery contribution		
					Number	Age class Percentage	Escapement
1979	.1				239		6.2
	.2				110		2.9
	.3				648		16.9
	.4				12		0.3
	Total	3,830	N.A.	N.A.	1,009		26.3
1980	.1	266	55	10.5	205	77.1	8.1
	.2	586	121	23.1	209	35.7	8.2
	.3	961	198	37.9	218	22.7	8.6
	.4	723	149	28.5	91	12.6	3.6
	Total	2,536	523	100.0	723		28.5
1981	.1	90	18	3.0	N.D.	N.D.	N.D.
	.2	792	157	26.3	607	76.6	20.2
	.3	1,258	250	41.8	303	24.1	10.1
	.4	870	173	28.9	123	14.1	4.1
	Total	3,010	598	100.0	1,033	34.3	34.3

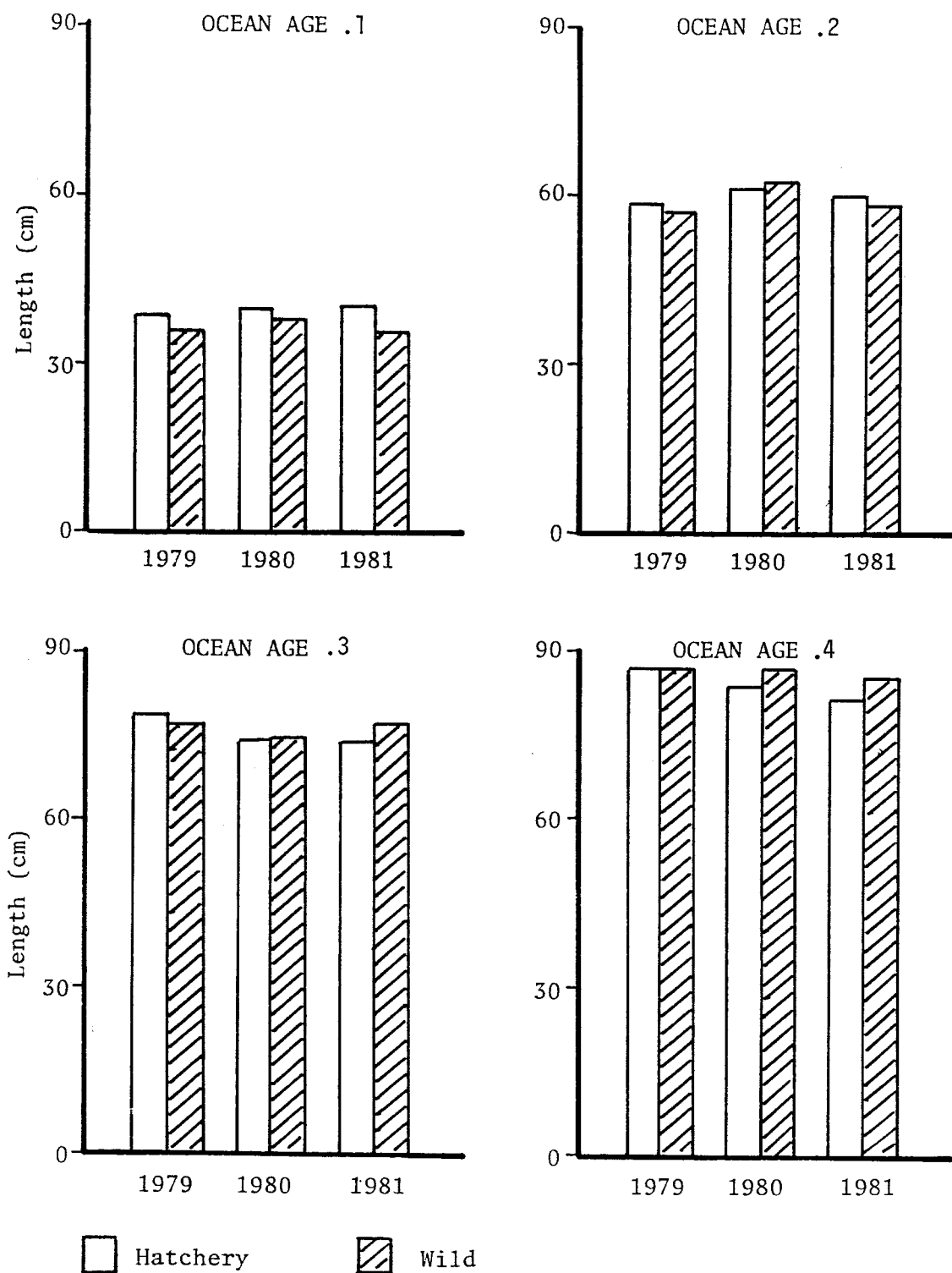


Figure 7. Age and average length comparisons between hatchery and wild Crooked Creek chinook salmon, 1979-1981.

Table 8. Lengths and weights of adult wild and hatchery produced Crooked Creek chinook salmon, 1979-1981.

Return year	Ocean age	<u>Length (cm)</u>						Significant Difference	t	df	p
		Hatchery			Wild						
		n	$\bar{x}$	s'	n	$\bar{x}$	s'				
1979	.1	43	38	3.2	18	35	3.5	Yes	3.25	59	<0.002
	.2	50	59	4.8	75	58	5.7	No	1.02	123	>0.200
	.3	140	79	5.0	147	77	5.2	Yes	3.32	285	<0.002
	.4	11	88	7.0	183	88	6.5	No	0	192	>0.500
1980	.1	22	41	2.6	6	38	7.0	No	1.69	26	>0.100
	.2	49	61	6.0	48	61	6.6	No	0	95	>0.500
	.3	79	74	4.6	128	75	4.8	No	1.48	205	>0.100
	.4	25	84	4.0	125	88	4.8	Yes	3.90	148	<0.001
1981	.1	5	41	9.0	2	35	1.4	No	0.89	5	>0.200
	.2	126	60	5.4	40	60	7.1	No	0	164	>0.500
	.3	106	74	5.9	101	77	4.1	Yes	4.23	205	<0.001
	.4	55	82	6.2	79	86	5.7	Yes	3.85	132	<0.001
<u>Weight (kg)</u>											
1979	.1	43	0.9	0.3	18	0.8	0.3	No	1.19	59	>0.200
	.2	50	3.5	1.4	75	3.3	0.9	No	0.97	123	>0.200
	.3	140	8.0	1.5	147	7.7	1.5	No	1.69	285	>0.050
	.4	11	10.4	2.2	183	10.8	2.7	No	0.48	192	>0.500
1980	.1	22	1.5	0.4	6	1.8	1.0	No	1.15	26	>0.200
	.2	49	4.4	1.3	48	4.3	1.5	No	0.35	95	>0.500
	.3	79	7.0	1.3	128	7.7	1.4	Yes	3.59	205	<0.001
	.4	25	10.4	1.8	125	11.7	2.5	Yes	2.47	148	<0.020
1981	.1	5	1.7	1.5	2	0.6	0.1	No	0.98	5	>0.020
	.2	126	3.9	1.0	40	3.8	1.3	No	0.51	164	>0.500
	.3	106	7.0	1.3	101	7.7	1.3	Yes	3.87	205	<0.001
	.4	55	8.9	1.9	79	10.7	1.8	Yes	5.57	132	<0.001

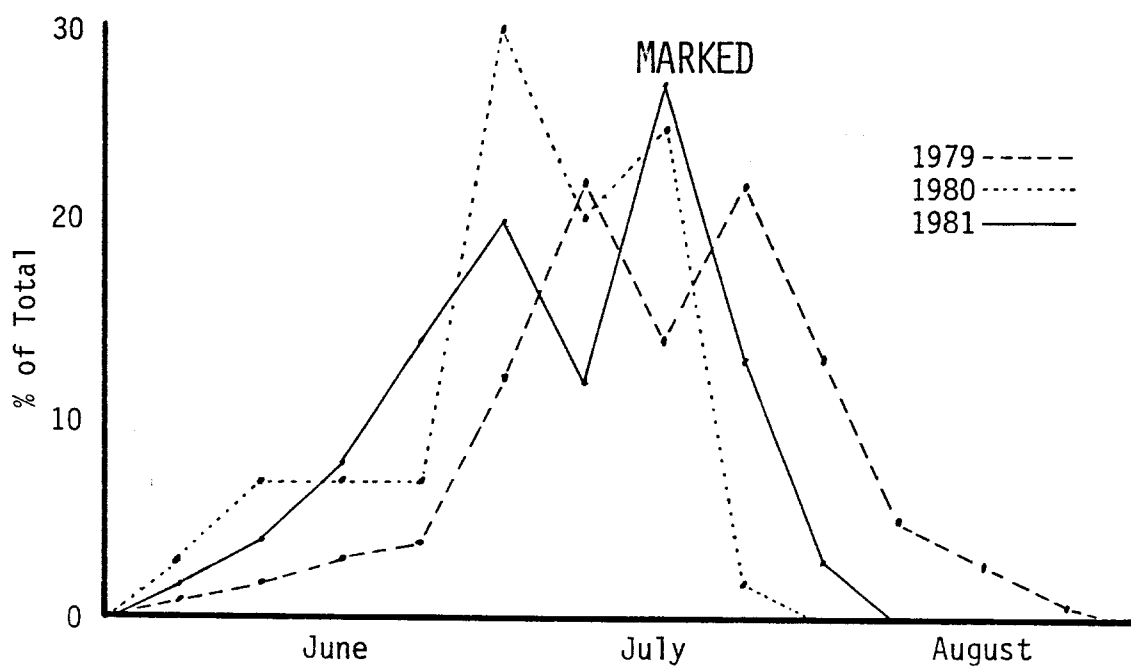
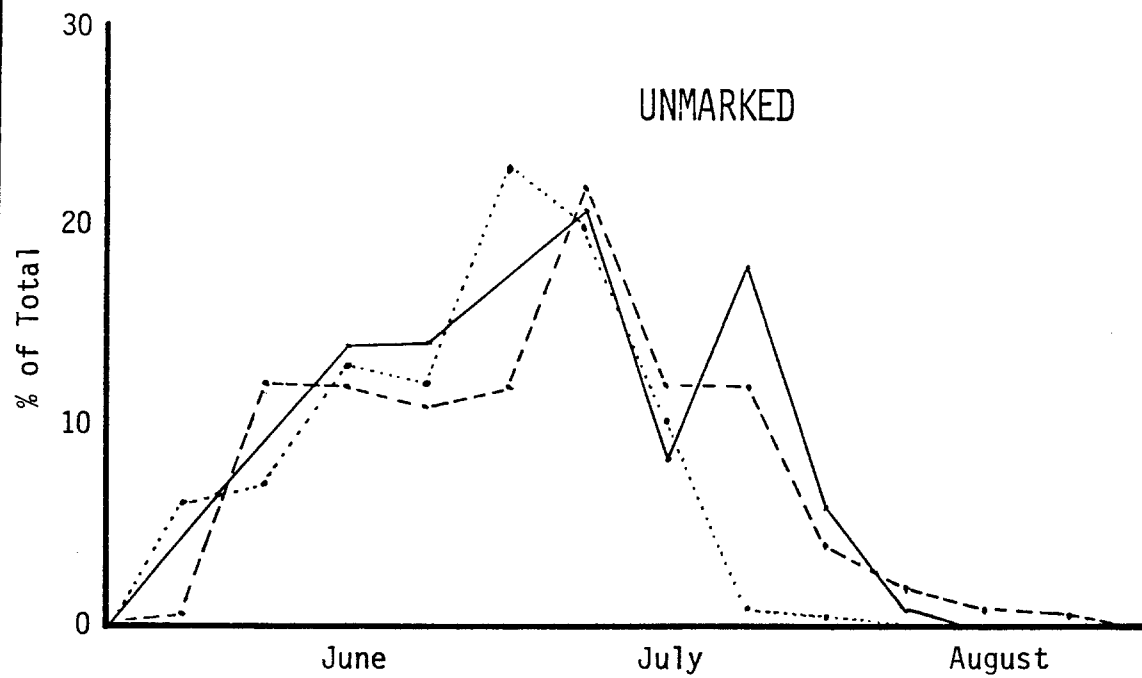


Figure 8. Percentage of marked and unmarked adult chinook salmon examined weekly at the Crooked Creek weir, 1979-1980.

fish from wild fish. A preliminary comparison of these techniques was performed during 1980 and 1981 (Table 9). Among adults returning during 1980, the estimated proportion of hatchery-produced fish within each age-class and for the total escapement is similar for both methods. Among adults returning during 1981, however, there is a slight difference in the estimated proportion of hatchery-produced fish within each age-class, and the estimated proportion of hatchery-produced fish in the total escapement was higher based on the scale analysis technique than the CWT analysis.

Table 9. Estimated proportion of adult Crooked Creek hatchery-produced chinook salmon in the escapement based on analysis of coded-wire tags and scales, 1980-81.

Return year	Age class	Total escapement	Hatchery-produced fish estimated from CWT analysis			Hatchery-produced fish estimated from scale analysis			
			Number	Percentage within each age class	Percentage of total escapement	Number of scales analyzed	Number of hatchery fish	Percentage within each age class	Percentage of total escapement
1980	.1	266	205	77.1	8.1	28	22	78.6	5.2
	.2	586	209	35.7	8.2	79	31	39.2	7.3
	.3	961	218	22.7	8.6	176	50	28.4	11.8
	.4	723	91	12.6	3.6	141	16	11.3	3.8
	Total	2,536	723		28.5	424	119		28.1
1981	.1	90	ND	ND	ND	7	5	71.4	1.2
	.2	792	607	77.6	20.2	121	83	68.6	20.6
	.3	1,258	303	24.1	10.1	165	50	30.3	12.4
	.4	870	123	14.1	4.1	109	20	18.3	5.0
	Total	3,010	1,033	34.3	34.3	402	158		39.3

## DISCUSSION

The total average survival rate of hatchery-reared Crooked Creek chinook salmon, from smolt to adult was 1.4% for brood years 1974 to 1976. This survival rate is approximately half of the expected survival rate (Fisheries Rehabilitation, Enhancement and Development Division, 1978). During the 1978 creel survey, however, only two marked chinook salmon were observed. If these data are used in the calculations, the total estimated survival rate for smolts of the 1974 brood year is 1.89%; whereas, the survival rate of smolts to the escapement from the 1978 brood year was only 1.09% (Table 5). If these data are ignored and not included in the calculations, the total estimated survival rate for the three brood years is only 1.17%. However, these survival rates were within the range found for hatchery-reared chinook salmon in other studies (Table 10). McHenry (1982) reported that the survival rate of hatchery-reared chinook salmon smolts released near Seward, Alaska was only 0.05%; while Heard (personal communication) reported that the survival rate of one treatment group of chinook salmon smolts at Little Port Walter was 14%.

The survival rate of the Crooked Creek chinook salmon may be lower than expected because the smolts were age 0.0 at the time of release, while most wild smolts migrate at age 1.0. Dudiak (unpublished data), however, observed survival rates similar to those I observed, while McHenry (1982) observed a much lower survival rate. Their studies are based on releases of smolts from the same "accelerated growth" hatchery program as Crooked Creeks'. Leon (personal communication), however, reported that another lot of age 0.0 smolts at Crystal Lake Hatchery had a survival rate of 7.5%. Apparently, other factors such as imprinting and release timing may be more important than the size the smolts at the time of release (Heard, personal communication; Reimers 1979).

I believe the estimated survival rates of returning hatchery chinook salmon at Crooked Creek are minimal estimates. The actual survival rate may be higher because of several reasons. Since age .1 fish are not sampled quantitatively at the weir, the estimated survival rate would be higher if all of these fish could be intercepted and counted. Currently, it is not known if there are any other fisheries which intercept chinook salmon returning to Crooked Creek. The Crooked Creek chinook salmon smolt-to-adult survival would be higher if the number of fish taken in other fisheries (including foreign) were known. It is likely that Crooked Creek chinook salmon pass through the marine sport fishery in lower Cook Inlet that occurs from mid May through July. A creel survey of this fishery will be conducted by SFD personnel during 1982. They will screen catches to determine if any fin-clipped chinook salmon are caught. Since the commercial fishery in Cook Inlet begins the last week of June, most Crooked Creek chinook salmon are already in the Kasilof River or Crooked Creek by that time. During the 1981 commercial fishing season, an extensive survey of canneries was performed to search for fin-clipped chinook salmon. Only one tag was found, which implies

Table 10. Brood year, location, release size, age at release and estimated survival rate of hatchery reared chinook salmon smolts in Alaska.

Report	Brood year	Location	Release size (g)	Age at release	Estimated survival rate (%)
McHenry (1982) Annual Report, 1981	1975-1976	Box Canyon Creek	19.6-30.7	0.0	0.04-0.06
Leon, Unpub. data	ND	Deer Mountain	ND	0.0	0.20
Dudiak, Unpub. data	1976	Halibut Cove	28.4	0.0	0.60
Waite, Table 5	1974-1976	Crooked Creek	19.6-28.3	0.0	0.94-1.90
Dudiak, Unpub. data	1975	Halibut Cove	27.6	0.0	2.80
Leon, Unpub. data	1976	Crystal Lake	11.3	0.0	7.50
Heard, Unpub. data	1976	Little Port Walter	63.9-84.6	1.0	1.00-14.00



that the commercial fisheries interception of the Crooked Creek chinook salmon stocks is negligible.

The 1982 hatchery program at Crooked Creek will include releasing fingerlings and smolts at different ages, and sizes. There are approximately 120,000 fry from the 1981 brood year. Of these approximately half will be released in late summer or fall of 1982 as fingerlings; the second group will be released during spring 1983 as age 1.0 smolts. Each group will receive a half-length coded wire tag with a different code. This release strategy is designed to evaluate the survival rates to adults and to determine the most cost effective hatchery procedure.

Between 1978 and 1981, the number of chinook salmon harvested increased each year and the number and percentage of hatchery chinook salmon in catches has increased as well (Table 2). In spite of an increase in angler effort, the harvest rate was good, except during 1980. Usually, the harvest rate was lower on weekends than on weekdays.

Hatchery-released chinook salmon contribute substantially to the Crooked Creek sport fishery. The number of fishermen in the area increased dramatically between 1978 and 1981 because of advertising, angling success, and word-of-mouth by fishermen. The Crooked Creek/Kasilof River chinook salmon fishery has greatly increased the opportunity for Kenai Peninsula anglers to fish from the shore with a good likelihood of catching fish. Unfortunately one-third of the fishing area and the access road is located on private land (the other two-thirds is on State land). The owner has expressed concern over the intrusion by the anglers, but has made an effort to cooperate with ADF&G. The owner is willing to sell the land to the State, and the Alaska Department of Natural Resources, Division of Lands is considering it a priority in their land acquisition plans. The catches and the harvest rates of this recently developed sport fishery are of the same order of magnitude as the more widely publicized sport fisheries on the Kenai Peninsula. The mean combined harvest for the fresh water fishery on three lower Kenai Peninsula streams, Deep Creek, Ninilchik River, and Anchor River, from 1971 to 1981 was 1,530 (Hammarstrom 1981). The mean harvest for the Kenai River chinook fishery from 1974 through 1980 was 6,029, but only 4% of this catch was taken by shore anglers. The mean catch per unit effort was 0.027 even though the shore anglers contributed approximately 10% of the effort (Hammarstrom pers. comm. 1981).

The age structure of chinook salmon reported in the sport fishery was different from that observed in the escapement. Age .1 chinook salmon rarely enter the fishery and they are not included in these data; but if caught, they are often kept. Sport fishermen in this area are required to record catches of chinook salmon measuring over 51 cm in length on a punch card (Alaska Board of Fisheries 1980). Most age .2 chinook salmon are longer than this. As a result, fishermen will catch and release age .2 chinook salmon in hopes of catching larger fish. Also, the large chinook salmon are difficult for shore anglers to land. Consequently, most of the chinook salmon caught and kept are age .3.

The creel survey conducted on the Kasilof River offered an excellent opportunity for employee-public communication. Many questions were answered about the fishery and FRED Division's program.

A sport fishery generates a considerable economic value into the locality where the fishery takes place. Hartman (personal communication) estimated that each angler day of effort in this fishery had a net value of \$82. Since there was a total of 8,751 man-days of effort on the Kasilof River in 1981, the estimated economic value of this fishery was \$735,084.

The hatchery-produced chinook salmon are contributing to the naturally spawning population as well as the egg take. Between 1979 and 1981, the hatchery-produced chinook salmon have contributed approximately 1,000 fish to this population and the percentage of hatchery fish in this population has ranged from 26 to 34%.

In most respects, there are no apparent differences in population characteristics between wild and hatchery fish. The adult chinook salmon run timing was approximately the same each year from 1979 through 1981 and the run timing of hatchery fish and wild fish was similar. The average sizes of returning adult chinook salmon within each age group was similar for hatchery and wild fish. The age .3 and .4 wild chinook salmon were slightly larger than the ages .3 and .4 hatchery chinook salmon. The biological significance of these differences, however, is not apparent. It may be that this difference is related to the fact that hatchery fish are released as age 0.0 smolts, whereas wild Crooked Creek chinook salmon smolts migrate as age 1.0. In other words, the freshwater age of hatchery and wild chinooks is different, with hatchery fish being 1 year younger.

It appears that hatchery-produced Crooked Creek chinook salmon return as ocean age .1 more frequently than wild Crooked Creek chinook salmon. Kissner (1980) also observed a large contribution of wild ocean age .1 chinook salmon in Southeastern Alaska. In most studies, this age class is not considered since little information is available for comparison. Since the weir on Crooked Creek does not sample this age class efficiently, it is likely that they comprise an even larger portion of the escapement and the actual survival rate is higher than reported. Unfortunately, this age class does not contribute substantially to the sport harvest or the egg take. If the reason these fish returned as age .1 could be counteracted so that more fish returned as older fish, the sport fishery would benefit greatly.

The 379,478 smolts released in 1979 have apparently survived well and will be a strong year class. Many returned as age .1 in 1980 and as age .2 in 1981. Consequently, we expect that the harvest and contribution of age .3 hatchery-reared adults in 1982 will be substantial.

Though attempts were made from 1979 to 1981 to monitor the chinook salmon smolt migrations, none was successful. Prior to 1979, movements of hatchery-released smolts were monitored by fishing minnow traps (Waite 1979). Because some marked smolts were trapped at the mouth of Crooked Creek the same day they were released, I believe that the

hatchery smolts migrate downstream within 24 hours of release. Also, during the spring chinook salmon sport fishery on the Kasilof River, several of the marked smolts were caught by anglers. A few marked chinook salmon smolts, however, were trapped in Crooked Creek in the winter of 1976-77. This suggests that occasionally some of the planted fish may overwinter in Crooked Creek. All of these marked fish exhibited parr marks.

Depending on the extent of this behavior, scale-reading of Crooked Creek chinook salmon may be a useful tool to separate hatchery chinook salmon from wild chinook salmon. Hatchery smolts are released after one year (age 0.0), and most wild smolts enter salt water as age 1.0 during their second year. During both 1980 and 1981, the estimated contribution of hatchery-reared chinook salmon in the Crooked Creek escapement was based on tag and scale analysis. The results obtained from applying each method to estimate the contribution for each age class are encouraging and, though detailed analysis and comparison of these marking techniques is beyond the scope of this report, we are continuing to investigate the usefulness of this method. If this method of distinguishing hatchery fish from wild fish is appropriate, it will provide a valuable and an economical tool for this program. Providing that the hatchery smolt production program does not change, all hatchery smolts will be "marked" when released because their scales will not have a freshwater winter check.

Presently, little is known about Crooked Creek wild smolt production and survival to adult. Continuation of this study, especially to compare the hatchery chinook salmon with natural populations, may be invaluable. Currently, this is the only extensive program in the state in which chinook salmon are stocked in a stream with a wild population (Heard pers. comm. 1981). An understanding of this enhancement effort may be useful for establishing other programs. The project in FY 83 includes smolt trapping in Crooked Creek with inclined plane traps. This program is designed to estimate the number of wild smolts and evaluate downstream movements of hatchery-released chinook salmon. Ultimately, estimates and comparisons of ocean survivals (smolt to adult) of wild and hatchery smolts may be obtained.

#### Conclusions

1. The average estimated survival rate, from smolt to adult for three complete hatchery brood years was 1.4%.
2. Hatchery fish have comprised an average of 30% of the run from 1979 through 1981.
3. Returning adult Crooked Creek chinook salmon contribute substantially to a valuable sport fishery which compares favorably with other chinook salmon fisheries on the Kenai Peninsula.
4. Few adult Crooked Creek chinook salmon appear to be intercepted by the commercial fishery, but the marine sport fishery may intercept some.

5. Within each age class of returning Crooked Creek chinook salmon, there are few differences between the sizes of hatchery-reared and wild fish.
6. With current hatchery techniques, there is some evidence that most hatchery-released smolts are characterized by the absence of a winter check in the freshwater zone of their scales. This may prove to be a useful recognition character.

#### Recommendations

1. Continue with the present program including a follow up on the evaluation of hatchery releases in 1982.
2. Continue the smolt study, which will start in 1982. A successful program will lead to a population estimate of wild smolts and increase the data base for the hatchery-released smolts. Comparison of contribution of ocean survivals of wild smolts with hatchery smolts may be made.
3. Conduct a more intense creel census on the marine, Kasilof River, and Crooked Creek fisheries to obtain more accurate harvest information. This program should be continued since it is expected that these fisheries will intensify.
4. Continue to encourage the State Department of Natural Resources, Division of Lands, to acquire the private land that borders the Kasilof River sport fishery. This would insure access to this fishery.

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Appendix A. Crooked Creek chinook salmon escapement<sup>1/</sup>, number of adults

held for egg take, holding and weir mortality, number of eggs taken and fecundity, 1974-1981. (M = male, F = female).

Year	Escapement		Crooked Creek Below Weir	Sport Caught	Total run
	M	F			
1974	184	96	ND	ND	280
1975	167	176	ND	ND	343
1976	1,143	539	96	ND	1,778
1977	2,054	1,015	125	ND	3,194
1978	2,730	1,985	117	251	5,083
1979	1,764	1,780	55	283	3,882
1980	1,169	1,113	73	320	2,675
1981	1,899	1,005	76	1,283	4,263

Year	Total number held for egg take		Holding and mortality at weir		Fish used for egg take		Total Number eggs taken	Fecundity
	M	F	M	F	M	F		
1974	15	25	1	6	12	19	155,350	8,176
1975	29	46	0	7	32	40	300,000	7,500
1976	123	124	0	5	123	113	835,600	7,395
1977	304	376	150	199	232	223	1,474,000	6,610
1978	176	273	89	153	87	115	823,000	7,157
1979	107	233	66	175	76	105	671,792	6,398
1980	89	132	24	49	73	94	533,350	5,674
1981	25	36	12	0	25	24	172,783	7,199

<sup>1/</sup> Age .1 "jacks" are excluded from this table.



Appendix B. Escapement timing, dates for arrival, fifty percent of the escapement passed weir, and end of run for the Crooked Creek chinook salmon, 1974-1981.

Year	Arrival At Weir	Date 50% Passed	Date Run Ended
1974	6/12	7/9	8/2
1975	6/11	7/8	7/28
1976	6/17	7/7	8/12
1977	6/3	6/30	7/29
1978	6/9	7/4	8/27
1979	5/30	7/4	8/24
1980	6/6	7/6	8/20
1981	6/16	7/5	8/14
1974- 1981 Average	6/9	7/5	8/12

Appendix C. Age, weight and length samples of returning Crooked Creek adult chinook salmon, 1979-1981.

Year	Salt Water Age	Number Sampled	Age Class Composition (Percent)	$\bar{x}$	Length Range(cm)	s	$\bar{x}$	Weight Range(kg)	s
1979	.1	144	8.0	38	26-50	3.3	1.0	0.5-1.5	0.3
	.2	151	10.0	58	42-72	5.3	3.3	1.5-5.3	1.1
	.3	352	54.0	78	61-94	5.0	7.8	5.2-11.0	1.5
	.4	194	28.0	88	72-113	6.6	10.7	6.9-22.4	2.6
1980	.1	31	10.0	40	30-49	4.9	1.7	0.8-2.5	0.8
	.2	101	23.0	60	44-78	7.8	4.3	1.7-9.2	1.4
	.3	211	39.0	75	56-90	6.1	7.5	4.8-11.2	1.7
	.4	180	28.0	87	72-100	5.0	11.6	7.8-17.3	2.5
1981	.1	7	3.5	41	34-60	9.0	1.7	0.5-4.2	1.5
	.2	190	26.0	60	41-76	5.8	3.9	1.7-7.4	1.1
	.3	242	41.5	76	50-88	7.2	7.5	4.8-11.8	1.3
	.4	159	29.0	85	71-102	6.2	10.0	5.8-16.0	2.0

Appendix D. Crooked Creek weir chinook salmon counts, 1979<sup>1</sup>.

Date	Numbers of fish						Total (excluding age 1.1 and 0.1)		
	Age 1.1		Age 0.1		Age 1.2		Age 0.3 and 0.4	Daily	Accum.
	1.1	0.1	1.2	0.2	1.3	1.4			
May 30	0	0	0	0	3		0	3	3
31	0	0	2	0	8			10	13
Jun 1	0	0	3	0	3		2	8	21
2	0	0	0	0	0		0	0	21
3	0	0	0	0	0		0	0	21
4	0	0	0	0	3		0	3	24
5	0	0	0	0	0		0	0	24
6	0	0	2	1	24		0	27	51
7	3	0	8	0	80		1	89	140
8	0	0	0	0	0		0	0	140
9	2	0	7	1	64		0	72	212
10	0	0	0	0	0		0	0	212
11	4	0	6	0	100		0	106	318
12	3	0	8	0	104		1	113	431
13	0	0	1	0	5		0	6	437
14	0	0	3	2	69		1	75	512
15	0	0	5	0	13		0	18	530
16	0	0	0	0	0		0	0	530
17	2	0	17	0	155		1	173	703
18	4	0	16	0	88		3	107	810
19	1	0	6	1	36		0	43	853
20	2	0	46	0	144		6	196	1,049
21	0	0	0	0	0		0	0	1,049
22	7	1	10	0	90		2	102	1,151
23	0	0	0	0	0		0	0	1,151
24	0	0	0	0	0		0	0	1,151
25	1	0	1	0	77		1	79	1,230
26	0	0	0	0	0		0	0	1,230
27	2	0	3	0	58		3	64	1,294
28	0	0	0	0	0		0	0	1,294
29	9	0	9	0	78		1	88	1,382
30	0	0	0	0	0		0	0	1,382
Jul 1	0	0	0	0	0		0	0	1,382
2	3	0	11	0	109		6	126	1,508
3	0	2	15	3	166		17	201	1,709
4	0	0	0	0	0		0	0	1,709
5	0	2	23	2	417		27	469	2,178
6	3	0	6	3	47		8	64	2,242
7	0	0	0	0	0		0	0	2,242
8	0	0	0	0	0		0	0	2,242
9	0	0	3	1	84		3	91	2,333
10	7	2	18	5	149		6	178	2,511
11	10	2	21	6	117		5	149	2,660
12	8	0	11	3	140		8	162	2,822
13	2	5	1	1	62		2	66	2,888
14	1	0	0	0	0		0	0	2,888
15	0	0	0	0	0		0	0	2,888
16	0	0	0	0	0		0	0	2,888
17	6	0	1	1	33		3	38	2,926
18	5	1	6	3	72		7	88	3,014
19	17	1	5	1	114		16	136	3,150
20	14	1	7	2	89		7	105	3,255
21	0	0	0	0	0		0	0	3,255
22	0	0	0	0	0		0	0	3,255
23	1	0	1	2	66		10	79	3,334
24	10	2	2	1	16		2	21	3,355
25	7	1	2	0	20		3	25	3,380
26	11	4	5	2	36		9	52	3,433
27	14	7	1	0	24		3	28	3,460
28	6	2	0	0	0		0	0	3,460
29	10	1	0	0	0		0	0	3,460
30	0	0	0	0	20		7	27	3,487
31	0	0	0	0	0		1	8	3,495
Aug 1	5	2	0	0	6		1	7	3,502
2	22	7	2	1	7		0	10	3,512
3	7	2	1	0	10		1	12	3,524
4	2	0	0	0	5		0	5	3,529
5	2	0	0	0	0		0	0	3,529
6	0	0	0	0	0		0	0	3,529
7	0	0	0	0	0		0	0	3,529
8	0	0	0	0	0		0	0	3,529
9	0	0	0	0	0		0	0	3,529
10	4	3	0	0	5		0	5	3,534
11	0	0	0	0	0		0	0	3,534
12	0	0	0	0	0		0	0	3,534
13	13	2	1	0	2		1	4	3,538
14	0	0	0	0	0		0	0	3,538
15	0	0	1	0	0		0	1	3,539
16	0	0	0	0	0		0	0	3,539
17	3	1	0	0	4		0	4	3,543
18	0	0	0	0	0		0	0	3,543
19	0	0	0	0	0		0	0	3,543
20	0	1	0	0	0		0	0	3,543
21	0	0	0	0	0		0	0	3,543
22	0	0	0	0	0		0	0	3,543
23	0	1	0	0	0		0	0	3,543
24	0	0	1	0	0		0	1	3,544
Total	233	53	298	42	3,029		175	3,544	3,544

<sup>1</sup>Age separation is based on size; age 0.1, 0.2, 0.3, and 0.4 refers to adipose fin clipped fish.

Appendix E. Crooked Creek weir chinook salmon counts, 1980<sup>1</sup>.

Date		Numbers of fish						Total (excluding age 1.1 and 0.1)		
		Age		Age		Age		Daily	Accum.	
		1.1	0.1	1.2	0.2	1.3 and 1.4	0.3 and 0.4			
Jun	6	1	0	2	0	22	0	24	24	
	7	1	0	4	0	43	2	49	73	
	8	0	2	2	0	49	1	52	125	
	9	0	0	0	0	0	0	0	125	
	10	1	0	7	0	15	1	23	148	
	11	0	0	0	0	0	0	0	148	
	12	0	0	0	0	0	0	0	148	
	13	0	0	0	0	6	0	6	154	
	14	0	0	0	0	0	0	0	154	
	15	0	0	1	0	47	2	50	204	
	16	1	0	18	0	40	7	65	269	
	17	0	0	0	0	0	0	0	269	
	18	1	0	18	0	41	2	61	330	
	19	0	0	0	0	0	0	0	330	
	20	0	0	10	0	0	0	10	340	
	21	0	0	0	0	0	0	0	340	
	22	0	0	0	0	0	0	0	340	
	23	6	1	38	4	68	1	111	451	
	24	7	0	0	0	92	4	96	547	
	25	0	0	0	0	0	0	0	547	
	26	10	2	34	1	52	0	87	634	
	27	11	2	0	0	89	4	93	727	
	28	0	0	0	0	0	0	0	727	
	29	0	0	0	0	0	0	0	727	
	30	0	0	3	0	35	2	40	767	
	Jul	1	11	1	13	1	40	1	55	822
		2	2	2	12	0	44	1	57	879
		3	5	0	14	0	35	1	50	929
		4	0	0	0	0	0	0	0	929
		5	4	0	26	2	68	3	99	1,028
6		0	0	0	0	0	0	0	1,028	
7		15	0	58	3	85	5	151	1,179	
8		24	3	35	4	58	8	105	1,284	
9		20	2	35	2	64	7	108	1,392	
10		2	0	29	6	59	5	99	1,491	
11		3	0	24	3	49	2	78	1,569	
12		0	0	0	0	0	0	0	1,569	
13		0	0	0	0	0	0	0	1,569	
14 <sup>2</sup>		0	0	50	0	100	0	150	1,719	
15		37	9	36	1	56	10	103	1,822	
16		0	0	0	0	63	0	63	1,885	
17		31	3	23	2	47	13	85	1,970	
18		5	1	9	1	17	2	29	1,999	
19		2	1	6	2	18	3	29	2,028	
20		0	0	0	0	0	0	0	2,028	
21		0	1	23	3	53	7	86	2,114	
22		6	1	26	4	44	8	82	2,196	
23		3	0	12	2	10	1	25	2,221	
24		2	0	8	3	9	2	22	2,243	
25		1	0	4	0	10	0	14	2,257	
26		0	0	0	0	0	0	0	2,257	
27		0	0	0	0	0	0	0	2,257	
28		3	0	7	2	4	0	13	2,270	
29		0	0	0	0	0	0	0	2,270	
30		1	0	0	0	1	1	2	2,272	
31		0	0	0	0	0	0	0	2,272	
Aug	1	0	0	0	0	0	0	2,272		
	2	4	0	0	0	0	0	2,272		
	3	3	0	0	0	0	0	2,272		
	4-20	0	0	0	0	10	0	10	2,282	
Total		223	31	587	46	1,543	106	2,282	2,282	

<sup>1</sup> Age separation is based on size; age 0.1, 0.2, 0.3, and 0.4 refers to adipose fin clipped fish.

<sup>2</sup> Estimate of fish escaping during high water.

Appendix F. Crooked Creek weir chinook salmon counts, 1981<sup>1</sup>.

Date	Number of fish						Total (excluding age 1.1 and 0.1)	
	Age		Age		Age		Daily	Accum.
	1.1	0.1	1.2	0.2	1.3 and 1.4	0.3 and 0.4		
Jun 16	2	0	14	0	22	0	36	36
17	4	0	15	0	118	3	136	172
18	0	0	0	0	0	0	0	172
19	12	0	22	1	178	4	205	377
20	0	0	0	0	0	0	0	377
21	0	0	0	0	0	0	0	377
22	13	0	45	1	136	4	186	563
23	0	0	0	0	0	0	0	563
24	7	0	35	2	73	1	111	674
25	0	0	0	0	0	0	0	674
26	14	0	34	5	96	2	137	811
27	0	0	0	0	0	0	0	811
28	0	0	0	0	0	0	0	811
29	6	0	41	2	117	7	167	978
30	0	0	0	0	0	0	0	978
Jul 1	12	0	33	8	127	12	180	1,158
2	0	0	0	0	0	0	0	1,158
3	0	0	0	0	0	0	0	1,158
4	0	0	0	0	0	0	0	1,158
5	0	0	0	0	0	0	0	1,158
6	10	0	102	8	179	6	295	1,453
7	0	0	0	0	0	0	0	1,453
8	4	0	60	8	108	4	180	1,633
9	0	0	0	0	0	0	0	1,633
10	5	0	43	7	142	7	199	1,832
11	0	0	0	0	0	0	0	1,832
12	0	0	0	0	0	0	0	1,832
13	0	0	22	4	53	8	87	1,919
14	0	0	0	0	0	0	0	1,919
15	5	0	80	8	83	5	176	2,095
16	0	0	0	0	0	0	0	2,095
17	0	0	0	0	0	0	0	2,095
18	0	0	0	0	0	0	0	2,095
19	0	0	0	0	0	0	0	2,095
20	0	0	0	0	0	0	0	2,095
21	3	0	54	9	274	21	358	2,453
22	0	0	0	0	0	0	0	2,453
23	0	0	0	0	0	0	0	2,453
24	3	0	97	12	106	13	228	2,681
25	0	0	0	0	0	0	0	2,681
26	0	0	0	0	0	0	0	2,681
27	0	0	0	0	0	0	0	2,681
28	3	0	50	8	57	13	128	2,809
29	0	0	0	0	0	0	0	2,809
30	0	0	0	0	0	0	0	2,809
31	1	0	23	1	32	5	61	2,870
Aug 1	0	0	0	0	0	0	0	2,870
2	0	0	0	0	0	0	0	2,870
3	2	0	12	1	4	2	19	2,889
4	0	0	0	0	0	0	0	2,889
5	0	0	0	0	0	0	0	2,889
6	0	0	6	2	2	0	10	2,899
7	0	0	0	0	0	0	0	2,899
8	0	0	0	0	0	0	0	2,899
9	0	0	0	0	0	0	0	2,899
10	0	0	0	0	1	0	1	2,900
11	0	0	0	0	0	0	0	2,900
12	0	0	0	0	0	0	0	2,900
13	0	0	0	0	0	0	0	2,900
14	0	0	3	0	0	1	4	2,904
Total	106	0	291	87	1,908	118	2,904	2,904

<sup>1</sup>Age separation is based on size; age 0.1, 0.2, 0.3, and 0.4 refers to adipose fin clipped fish.

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